



Advanced
Robotics Centre

Supported by:
Computing and Engineering

ZOOM with ARC

17th April 2020



Advanced
Robotics Centre

Introduction to Robotics & ARC

Assoc Prof Marcelo Ang



Agenda

Time	Talk topics	Speaker
2pm – 2.15pm	Introduction to Robotics and ARC	Assoc Prof Marcelo Ang
2.15pm - 2.25pm	Autonomous Mobile Robot & Internship Opportunities	Krittin
2.25pm – 2.35pm	Autonomous Mini-bus and Autonomous Clean	Shuo
2.35pm – 2.45pm	Soft robotics	May
2.45pm – 2.55pm	Manipulator (Cobots)	Eric
2.55pm – 3.00pm	Overview of projects	Assoc Prof Marcelo Ang
3.00pm – 3.30pm	Q&A	Moderator : Krittin

About Us

What is ARC?



Our Partners



- Established in 2013 with FOE and SOC
- Objectives:
 - Lead and support robotics research in NUS.
 - Train new robotics engineers
- 3 Track Focus:
 - Autonomous Mobile Robots/Vehicles
 - Industrial Robots
 - Service Robots

Our Work

3 Track Focus



**Autonomous Mobile
Robots / Vehicles**



**Industrial
Robot**



**Service
Robot**

Our Work

Autonomous Vehicle in Action

SPPAM: Safe Path Planning with GP-
Regulated Risk Map

H. Guo, Z. Meng, and D. Rus
SMART-FM

Our Work

Autonomous Vehicle in Action



Our Work

Robotics in action



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Robotics Centre

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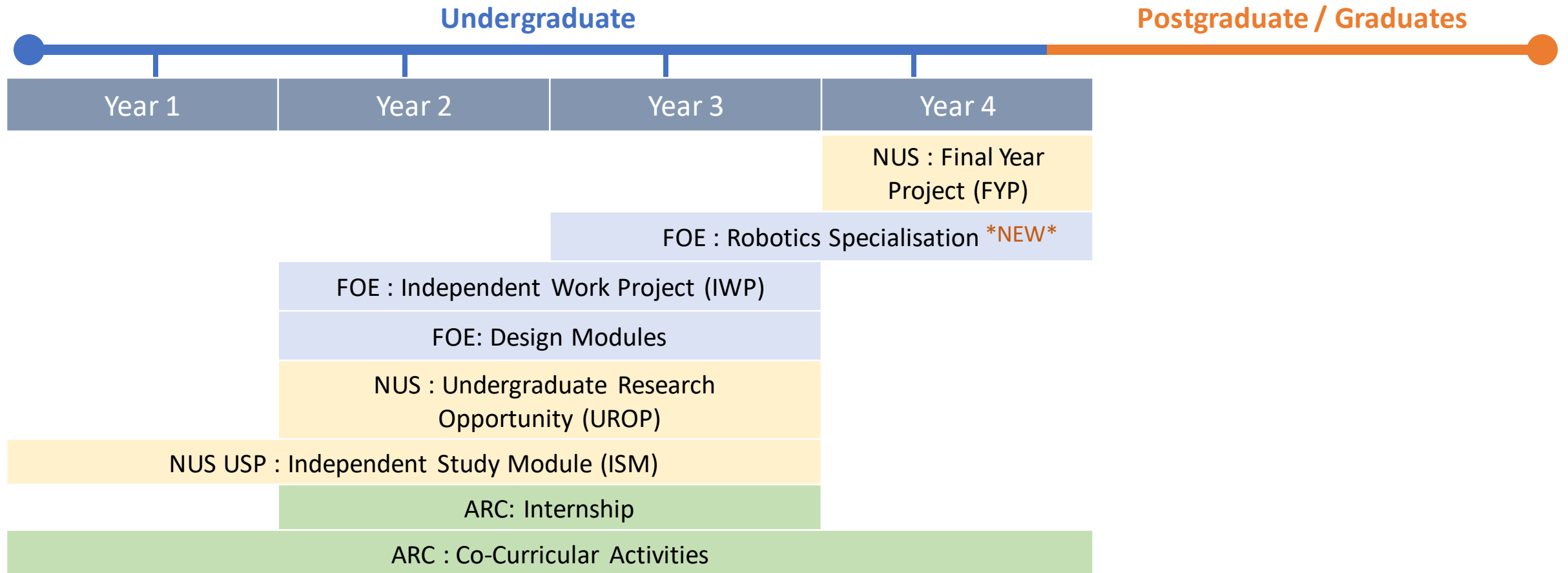
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Collaborative Intelligent Robotics System Based on KUKA IIWA

Chen Yiwen
cywgoog@gmail.com

Opportunities with ARC

For Passionate Robotics Engineers



Robotics Specialisation (FOE)

Bachelor of Engineering : Biomedical, Computer, Mechanical , Electrical

Admission : in Year 2 Sem II Only

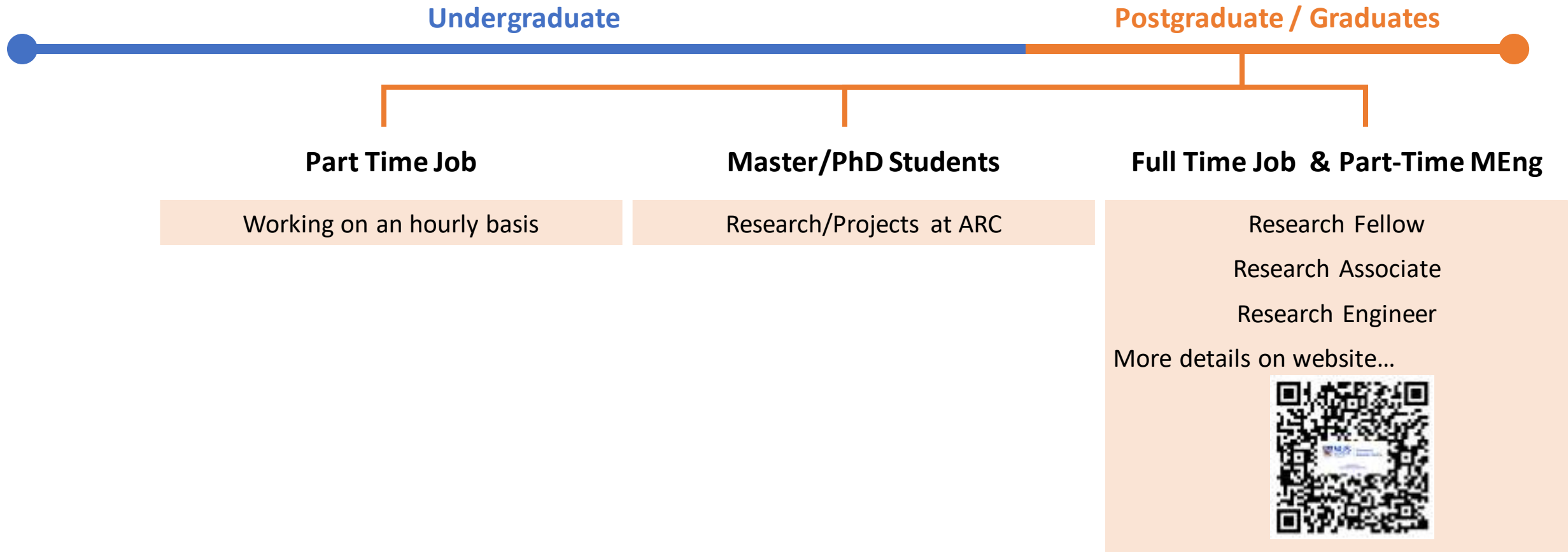
Requirements:

1. Complete a compulsory module ME3243/EE3305 Robotic System Design (4MC).
2. Complete a Final Year Project in the **area of Robotics**.
3. Complete three (3) **elective modules** (12MC) - *Modules shown below according to suggested tracks*

Track 1: Smart Mechanism Design	Track 2: Robot Intelligence	Track 3: Collaborative Systems
Robot Mechanics and Control	Autonomous Robot Systems	Robot Perception
Intelligent Medical Robotics	Fuzzy/Neural Systems for intelligent robotics	Human-Robot Interaction
Soft Robotics	Robot Perception	Soft Robotics
	Robot Mechanics and Control	Robotics in Rehabilitation

Opportunities with ARC

For Passionate Robotics Engineers





Autonomous Mobile Robot

Krittin Kawkeeree – Mobility Group Lead

About Myself

Robotics Research Engineer



Krittin Kawkeeree

- NUS Mechanical Engineering Graduate
- Robotics Research Engineer
 - Mobility Team Lead
 - Develop Autonomous Mobile Robot (Both hardware and software)



Email: mpekrk@nus.edu.sg

Mobility Group

Focus on Autonomous Navigation

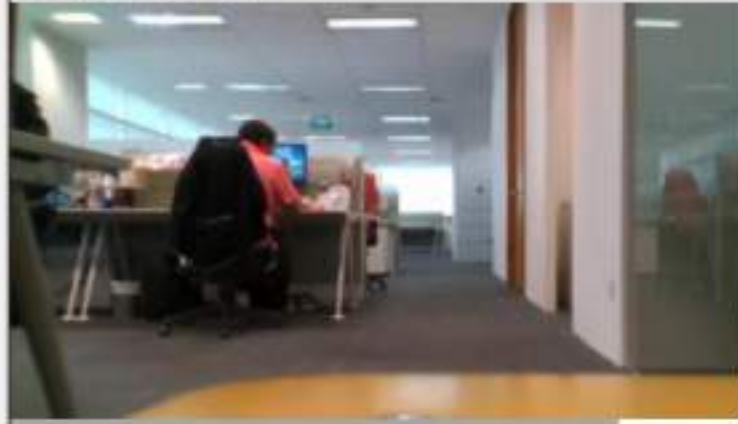




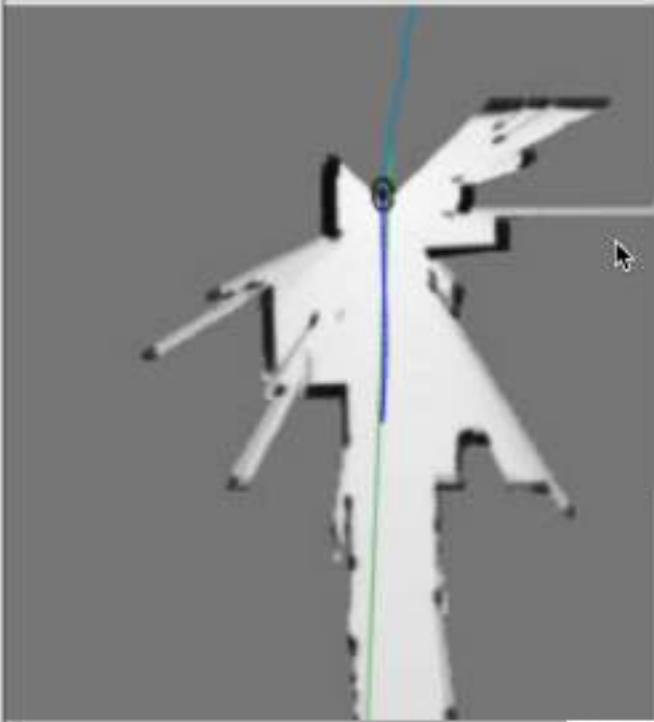
spot - Map View



RealSense Camera



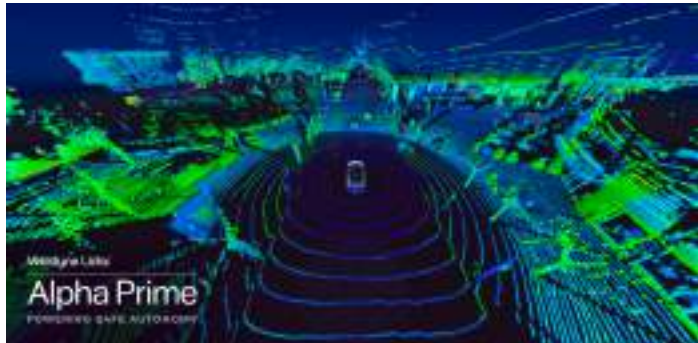
spot - Local View



nvidia
Isaac SDK

Sensors & Equipment

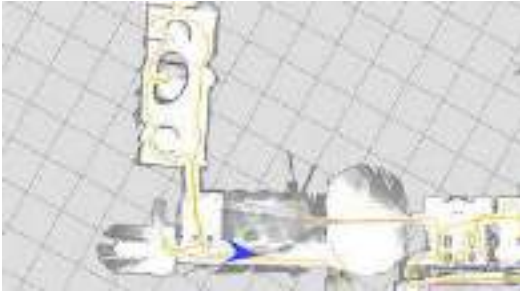
Hand-ons Experience on Real-Life Equipment



Learning Outcomes

Hands-on Experience on Autonomous Technology Development

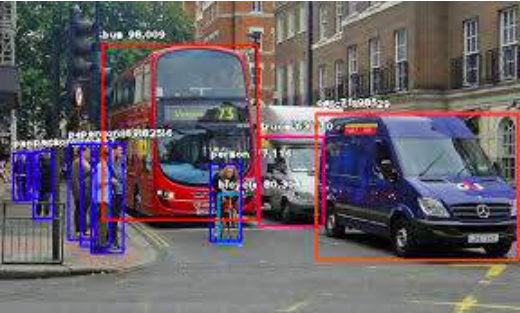
SLAM



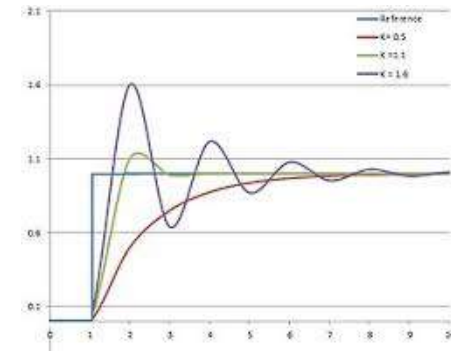
Navigation



Perception



Control



Previews of FYP and Other Projects on Mobile Robots

Multi-Disciplinary Projects

Autonomous Wheelchair (Indoor Robot)

Web-Based Control Centre

Object Detection Integration

Free Space Segmentation
Integration

Autonomous Legged Robot (Outdoor Robot)

Outdoor Autonomous
Navigation

Visual Odometry Integration

GPS/Beacon – Assisted
Localisation

Autonomous Tree- Inspection Robot (Outdoor Robot)

Light-Weight Robotics Arm
Design

Learning Outcomes:

C++, ROS, Python, Sensors & Hardware

- For more information on FYP topics and other related projects, please contact  mpekrk@nus.edu.sg

Internship Opportunity

@ ARC & GovTech - AY2021 Sem I IA Intake (Tentative)

Scope:

- Low-cost Autonomous Robot Development
- Location-based Services
- IoT Development

Mechanical Engineering (x1)

Electrical Engineering (x2)

Computer Engineering/
Computer Science (x2)

Scope:

- Autonomous Legged Robot Development

Mechanical Engineering (x2)

Electrical Engineering (x1)

Computer Engineering/
Computer Science (x2)

Look out for job posting
on ARC website:

<https://arc.nus.edu.sg/>

Autonomous Mini-bus Autonomous Clean

SUN Shuo

Autonomous Mini-bus

In collaboration with TURING



- 2020 July – 2023 April
- Objectives:
 - Research on Autonomous Technology
 - Teaching Platform: Train new robotics engineers
 - Service Trials on NUS campus

Autonomous Clean

In collaboration with Karcher



- **2020 July – 2023 April**
- **Objectives:**
 - Develop an Autonomous Outdoor Sweeping Robot
 - Conduct Trials @ UTown

Autonomous Vehicles

Previous Projects



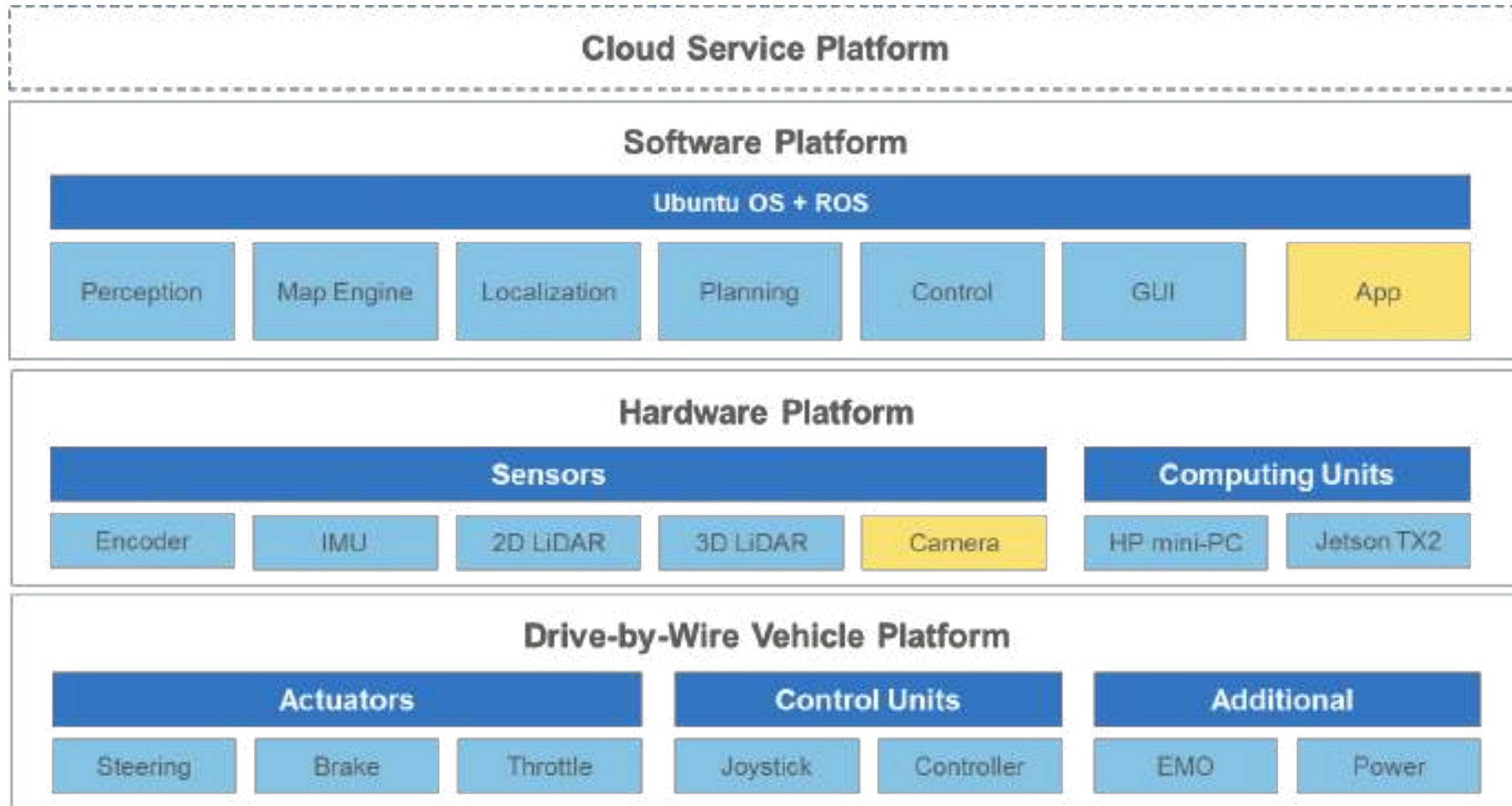
Autonomous Bus with ST Engineering



Autonomous Buggies @ Micron
(DPM and the Micron CEO sitting on our buggy)

Autonomous Vehicles

A Quick Introduction



FYP & Other Projects Available

No.	Project	Title
1	AV Mini-bus	Simulation of vehicle systems for the self-driving mini-bus development and testing
2	AV Mini-bus	Simulation of sensor models and realistic environments for the self-driving mini-bus development and testing
3	AV Mini-bus	Mechanical design and fabrication of self-driving mini-bus
4	AV Mini-bus	Firmware design and electrical architecture design of self-driving mini-bus
5	AV Mini-bus	Sensor configuration and integration for self-driving mini-bus
6	AV Mini-bus	Non-homogenous sensor suite fusion for object detection for self-driving mini-bus

No.	Project	Title
7	AV Mini-bus	Vision based multi-camera object detection for self-driving mini-bus
8	AV Mini-bus / AV Road Sweeper	Global path planning and optimisation for self-driving mini-bus and Autonomous Clean
9	AV Mini-bus / AV Road Sweeper	Path tracking and Local path planning and optimisation for self-driving mini-bus
10	AV Mini-bus / AV Road Sweeper/ AV Wheelchair	3D Mapping and localisation for self-driving mini-bus, Autonomous Clean and wheelchair
11	AV Road Sweeper	Autonomous platform DBW hardware
12	AV Road Sweeper	Autonomous platform DBW electronics
13	AV Road Sweeper	Autonomous platform DBW ROS stack

Autonomous Vehicles

A Quick Introduction – Hardware



- **Design the Drive-by-Wire System**
 - Steering, Throttle and Brake
 - Power System
 - Electrical Circuits
- **Installation of Sensors**
 - Sensor Coverage & Layout
 - Sensor Mounting & Aesthetics
- **Functional Safety**
- **Human-Machine Interface**

Autonomous Vehicles

A Quick Introduction - Hardware



What you will learn:

- Sensors and Actuators
- Vehicle Engineering
- CAD/CAM
- Robotics & Programming

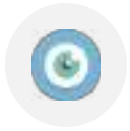
Gain Rich Experience in:

- Electro-mechanical Systems
- Hands-on Fabrication & Prototyping



Autonomous Vehicles

A Quick Introduction - Software



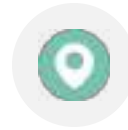
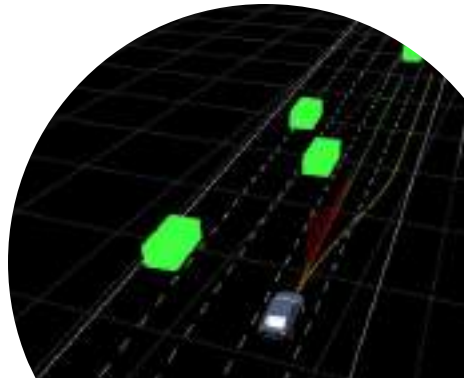
Perception

Fusing various sensors to detect and track obstacles



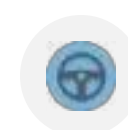
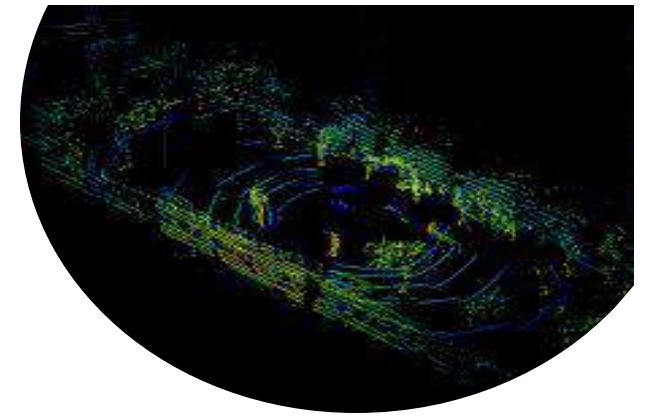
Decision-making

Making appropriate driving decisions in dynamic scenarios



SLAM

Simultaneous Localization and Mapping



Motion Control

Controlling the the vehicle to execute the path precisely



Autonomous Vehicles

A Quick Introduction - Software



What you will learn:

- C++, Python,
- Git, CMake, Linux
- Robot Operating Middleware
- Deep Learning

Gain Rich Experience in:

- Software Development
- Computer Vision, SLAM, Planning, Control Algorithms

Autonomous Vehicles Projects

What you will learn

- **State-of-the-Art Robotics knowledge, widely applicable in many industries**
- **Solving complex system-engineering problems**
- **Hands-on experience with real-world applications**

Autonomous Vehicles Projects

Other ways to join us

- **Undergraduate Research Opportunities Programme (UROP)**
- **Independent Study Modules (ie. ME3000)**
- **Design Projects**
- **Industrial Attachment**
- **Student Helpers @ ARC**



Soft Robotics

Assoc. Prof. Raye Yeow

Presented by: Khin P. May



SOFT ROBOTICS

Making robots with soft materials

Collaborative robots

- Soft compliant grasping solutions
- Industrial applications, i.e. food packaging, consumer goods packaging
- Assistive robots

Healthcare robots

- Rehabilitation devices
- Patients with conditions such as stroke
- Clinical trials

Collaborative Robots

Three-fingered grasping solution*



**In collaboration with NTU*

Learning Outcomes

Mechanical design / 3D design

Fast prototyping techniques

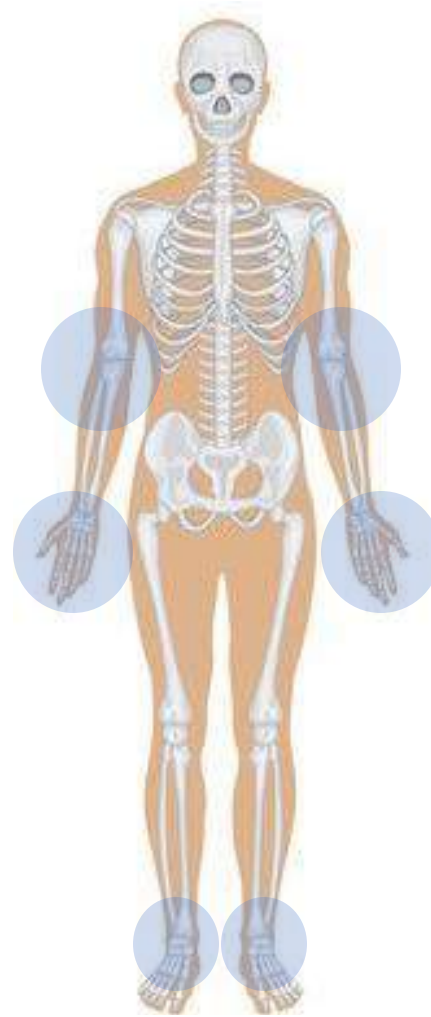
Control system

Programming knowledge

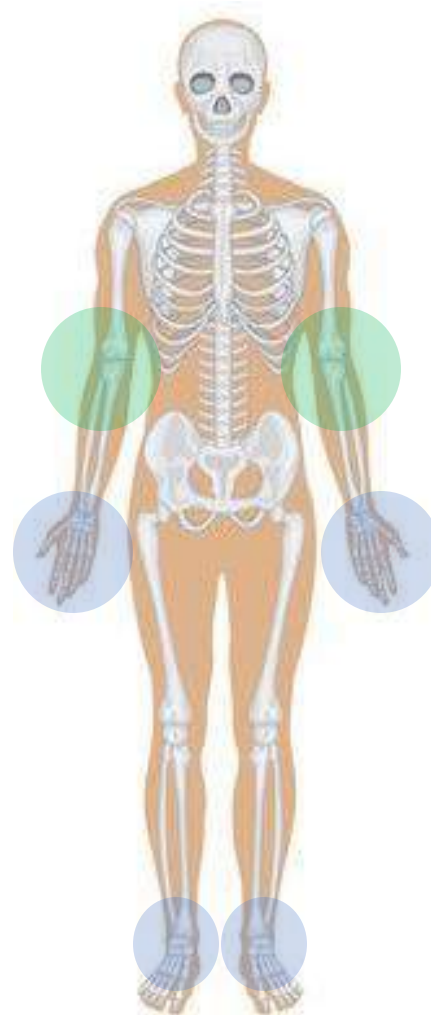
Healthcare Robots

Learning Outcomes

Knowledge of biomechanics
Mechanical design/ 3D design
Fast prototyping techniques
Control system
Programming knowledge



Healthcare Robots



Healthcare Robots

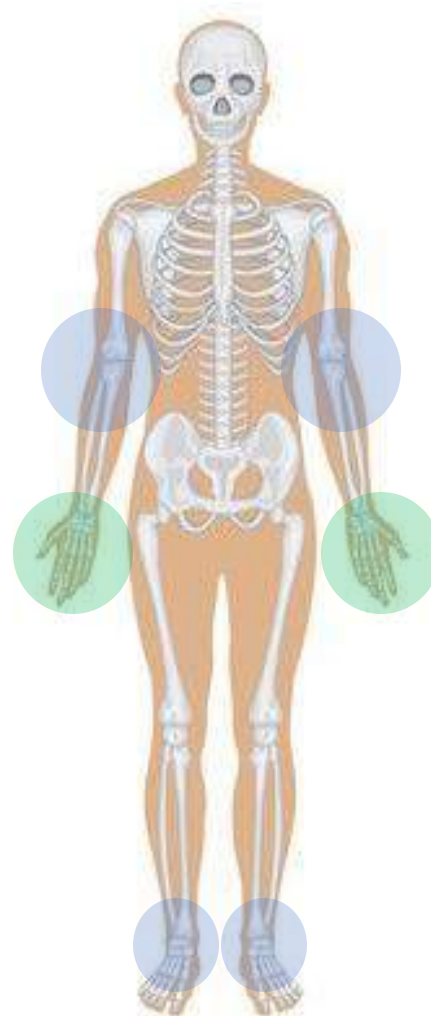
Upper Limb Assistive Device

Soft Torque-generating Actuation System (STAS)

- Antagonistic soft pneumatic actuators for bidirectional torque generation
- Elbow flexion assistance



Healthcare Robots



Healthcare Robots

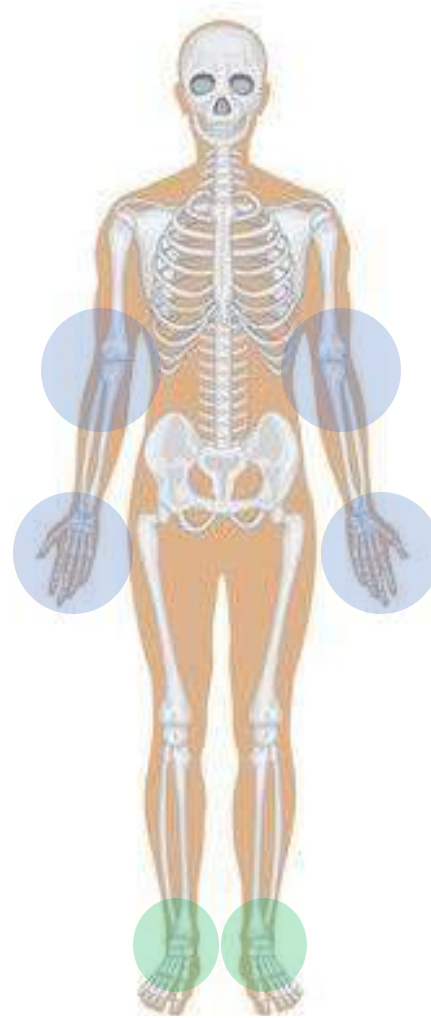
Upper Limb Assistive Device

Soft fabric-based glove

- Stroke patients
- Enable finger flexion and extension
- Clinical trials



Healthcare Robots



Healthcare Robots

Lower Limb Rehabilitation Device

Soft fabric-based sock

- Dorsiflexion and plantar flexion
- Deep vein thrombosis
- Clinical trials





Collaborative-AI

Presenter: Eric Kwok (Research Engineer)

What we do

- **Research and develop software interface and libraries to incorporate AI**
 - Skills learning
 - Object and voice detection
 - Commonsense understanding
- **Develop basic skills and actions for the robotic arm or mobile platform → Mobile manipulation**
 - Reusable by different tasks
 - Reusable by different robots



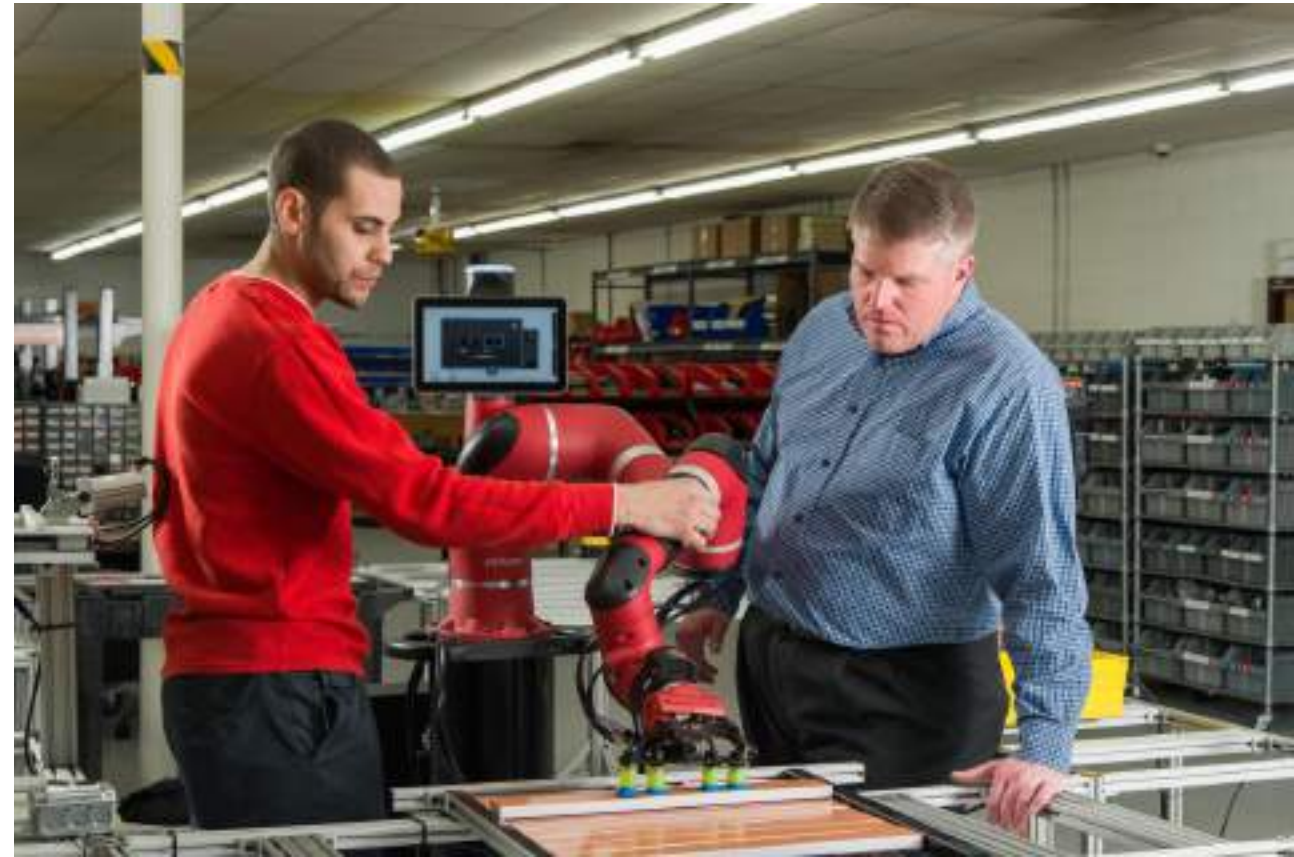
Why we do

- Traditional Manipulators:
 - Low-mixed high-volume production
 - Low adaptability
 - Routine and repeatable tasks
 - Caged. Not suitable to work alongside human beings due to safety reasons



Why we do

- Growing trend:
 - Increased investment in High-mixed Low-volume production in SG (Straits Times Jul 2019)
 - Aging population in many of the developed countries
 - Reduced in supply of local workers and high labor cost
 - Demand for robot that is adaptable to human-centric environment



What we aim to do

- Robots that can work alongside human without compromising safety
- Communicate with human and understand the environment
- Work on complex tasks and adapt to various changes
- Allow human to perform higher level tasks



What we can offer you

- **Projects**

- Development of mobile manipulators
 - Navigation skills
 - Robotic arms manipulations
 - Sensor fusion
- Development of UI/middleware to program industrial robots
 - Human centric UI development
 - Understanding of Robot Operating System (ROS)
- Advanced visual object trackers for vision-guided grasping tasks
 - Signal processing
 - Visual tracking
 - Machine learning



What we can offer you



Kuka liwa manipulator



Kinova Movo
mobile robot



Haptic device



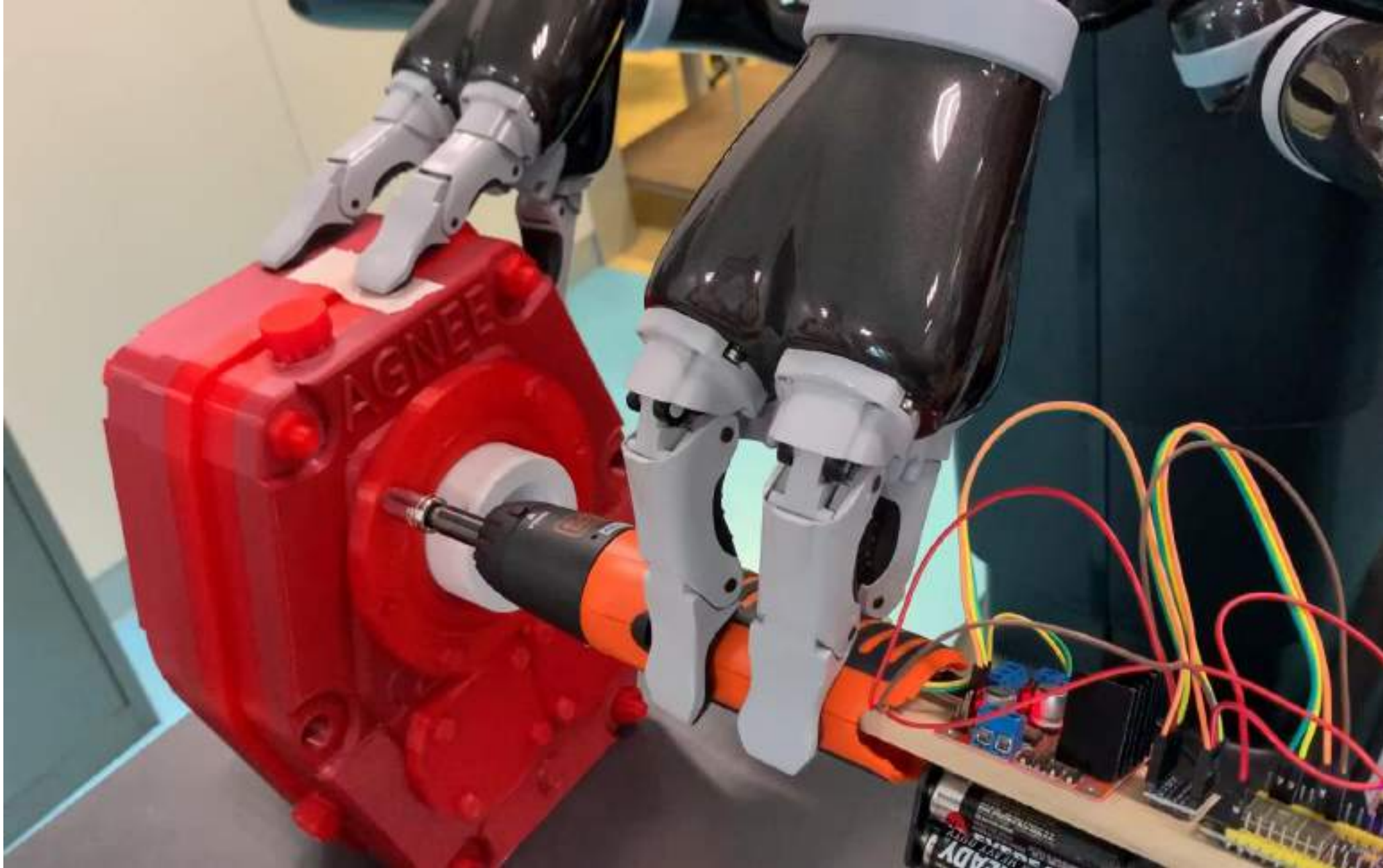
RGBD camera



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Chen Yiwen
cywgoog@gmail.com



Overview of Projects

Assoc Prof Marcelo Ang



Overview of Projects

Autonomous Vehicles/Robots	Industrial Robot	Service Robot
Mechanical Design for Fabrication	Mobile Manipulator	Bio-inspired locomotion
Electrical Hardware (Architecture Design , Configuration & Integration)	Object detection & tracking for grasping	Bio-inspired end-effectors for manipulation
Object Detection (Vision Based)	UI/middleware to program industrial robots	Bio-inspired robot for flight
Path Planning		
ROS Related : Control Optimisation, Multiple Robot Operations		
Sensor Fusion		
Simulation of autonomous vehicle		

Q&A

Ask Your Questions Live!

- Slido platform
 - Scan QR code
- OR
- Full url: <https://app.sli.do/event/okmqgy97/live/questions>
- OR
- Using the Slido app or at <https://www.sli.do/>
 - Event id: **75035**
- Zoom chat
- General follow-up: robotics@nus.edu.sg



Follow up emails

- General enquiries:
 - robotics@nus.edu.sg
- Mobile Robots:
 - mpekrk@nus.edu.sg
- Autonomous Vehicles:
 - shuo.sun@u.nus.edu
- Manipulator/Cobots:
 - mpeknt@nus.edu.sg
 - mpelix@nus.edu.sg
- Soft robotics:
 - biekpm@nus.edu.sg